A STUDY AND DEMONSTRATION OF LUMBER GRADE YIELD, DRYING, AND USE OF SOUTHWESTERN WALNUT

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Final Report

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Thanks are extended to Mr. Bill Schrecengost for permission to harvest the walnut trees, to Bell Dee for manufacture of lumber, and to the four firms that made the products from the lumber.

Further, the author wishes to thank Dr. Charles Minor for his assistance at N.A.U., and the following students who helped in the various phases of this study: Brad Blake, Gerald Tuskan, Phil Patterson, Bob Skaggs, Jenny Farenbaugh, and Paul Thomas.

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Problem

Production of wood furniture and related crafts is increasing in the Southwest, and there is additional potential for developing these industries. These ventures must now rely on eastern sources for fine hardwoods, with attendant high prices. Local sources of walnut should help reduce these material costs. However, the technical and economic feasibility of utilizing the Southwest's walnut for this purpose has not been established. Little is known about the lumber quality, drying characteristics, and suitability of this wood for commercial production. This study was designed to find technical answers to this problem.

Background Information

New Mexico and Arizona have appreciable volumes of Arizona walnut (*Juglans major* (Torr.) Heller) that potentially could be used in producing furniture or similar high value products.

The range of *Juglans major* (Arizona walnut) includes the foothills and mountains of southern Arizona and New Mexico, and also northern Mexico. Throughout these areas it occurs as scattered trees and small clumps along streams and in association with Fremont cottonwood, Arizona sycamore, and Gambel oak at elevations ranging from 3,500 feet to 7,000 feet.

Much of the lands on which this species occurs are in state and private ownership and only estimates are available at the present as to the approximate volumes. Between 0.5 MM and 1.0 MM board feet of lumber per year could possibly be produced from Arizona and New Mexico.

Study Objectives

The specific objectives of this study were:

1. Provide technical information about the yield of Arizona walnut lumber suitable for furniture making and related production and determine the processing characteristics of the wood.

2. Develop, through the application of various kiln drying schedules, the optimum schedule for this species.

3. Demonstrate the potential of Arizona walnut for use in furniture and related crafts.

Methods and Procedures

1. Twelve trees of Arizona walnut (approximately 1,400fbm, L.T.) were harvested and served as a representative sample of the timber found in New Mexico and Arizona.

2. The cubic foot volume of each tree was determined and other characteristics unique to the tree were noted. Specific gravity and moisture content of sample trees were computed.

3. The twelve sample trees were felled and bucked to a maximum length of 7 feet (experimental dry kiln limitation) and if less than 7 feet the sections were bucked in multiples of 1 foot. A total of 2-3 inches was allowed for trim allowance for each log section.

4. The sample logs were sawn into 4/4 and 8/4 thickness to maximize lumber grade. Log sections with diameters greater than 12 inches were milled at Dee's Sawmill, Mayhill, New Mexico. Logs smaller than the 12 inch diameter were sawn with NAU School of Forestry's bolter mill in Flagstaff, Arizona. The lumber recovery factor was determined for milling at both locations.

Three methods were employed to dry the wood from the green condition to a final moisture content of 7 percent: (a) kiln drying using the recommended schedules from the Dry Kiln Operators; Manual (Rasmussen, 1961) for black walnut, (b) air drying with final drying and stress relief, and (c) modified air drying where the top and sides of the bunk were covered with polyethylene wrapping and wood was dried under constant temperature inside the laboratory, and then kiln dried and residual stresses relieved.

For the 4/4 stock, the moderate schedule recommended was T6-D4.
See next page for kiln drying schedule.

Dry Kiln Schedules

Table 1

Kiln Schedule for Drying 4/4 Black Walnut

T6-D4

Temperature step no.	Moisture Content at start of step Percent	Dry bulb Temperature Degrees F	Wet bulb Temperature Degrees F	Wet Bulb Depression Degrees F
1	Above 50	120	113	7
2	50	120	110	10
3	40	120	105	15
4	35	120	95	25
5	30	130	90	40
6	25	140	90	50
7	20	150	100	50
8	15	180	130	50

Table 2, schedule T7-D4 depicts the intermediate schedule used for drying 4/4 walnut.

Table 2

Kiln Schedule for Drying 4/4 Black Walnut
Code Index T7-D4

Temperature step no.	Moisture Content at start of step Percent	Dry bulb Temperature Degrees F	Wet bulb Temperature Degrees F	Wet bulb Depression Degrees F
1	50	130	123	7
2	50	140	130	10
3	40	150	135	15
4	35	160	135	25
5	30	160	120	40
6	25	160	110	50
7	20	160	110	50
8	15	160	110	50

Table 3, schedule T8-D5 shows the severe schedule used for drying 4/4 walnut.

Table 3

Kiln Schedule for Drying 4/4 Black Walnut
Code Index T8-D5

Temperature step no.	Moisture Content at start of step Percent	Dry bulb Temperature Degrees F	Wet bulb Temperature Degrees F	Wet bulb Depression Degrees F
1	50	130	120	10
2	50	130	116	14
3	40	130	110	20
4	35	130	95	35
5	30	140	90	50
6	25	150	100	50
7	20	160	110	50
8	15	180	130	50

Table 4, T3-D3, was the moderate schedule used for drying the 8/4 walnut lumber.

Table 4

Kiln Schedule for Drying 8/4 Black Walnut
Code Index T3-D3

Temperature step no.	Moisture Content at start of step Percent	Dry bulb Temperature Degrees F	Wet bulb Temperature Degrees F	Wet bulb Depression Degrees F
1	50	110	105	5
2	50	110	103	7
3	40	110	99	11
4	35	110	91	19
5	30	120	85	35
6	25	130	80	50
7	20	140	90	50
8	15	160	110	50

After a charge had been run, the lumber was removed and visually examined for drying defects so as to determine whether a more severe drying schedule could be employed.

The lumber was graded according to the National Hardwood Lumber Association's grading rules for black walnut.

The lumber recovery factor was determined for each site where the logs were milled.

The kiln dried lumber was delivered to the following wood manufactures:

(a) Wood Kraze
5370 North Dodge
Flagstaff, Arizona

(b) Red Rock Cabinet Shop
228 West 89A
Sedona, ARizona

(c) Brentwood Cabinet Ship
1115 South Center
Mesa, Arizona

(d) Southwest Spanish Craftsmen, Inc.
922 Canyon Road
Santa Fe, New Mexico

The wood manufacturers agreed to use the wood and evaluate its performance in comparison with other hardwoods they had worked with. The categories evaluated included: sanding, machinability, natural defects, seasoning defects, gluing, finishing, handworking characteristics, checking and other (items not mentioned earlier but significant to the manufacturer).

Further, they were asked to respond about specific problems or concerns they might have about the species.

Summaries were returned and photgraphs taken of the various products manufactured.

Results and Discussion

Location and Ownership

Arizona walnut, Juglans major (Torr.) Heller) was collected for this study from private land owned by Bill Schrecengost one quarter mile north of Lincoln, New Mexico. Figure 1* shows the cross-section of this species and Figure 2 illustrates the walnut fruits. The walnut was located in south-central New Mexico in mid-elevation (3,500'-7,000') drainages. These drainages are located on private lands and are adjacent to the Lincoln National Forest. The closest large cities are Alamagordo to the south, Roswell to the east, and Socorro to the west. Walnut was identified along the Rio Bonito, Rio Hondo, and Rio Ruidoso, but data was collected for ownerships along the Rio Bonito.

Table 5

Partial Listing of Ownerships
Where Walnut Trees are Found

Owner	Miles of Bottomland
B. Pfinkston	17
R. Anderson	15
W. Schrecengost	11

Ownerships less than 1 mile include: Mann, Ramsey, Phillips, Booky, Amora, Dunlop, Salazar, Howard.

* Figures are found in the Appendix.

The Schrecengosts own most of the bottomland that passes through Lincoln, N.M. The Pfinkstons own land from Lincoln town limits to the junction of the Rio Hondo (approximately 17 miles of bottomland). R. Anderson owns 15 miles of bottomland from the Rio Hondo junction eastward.

Any attempt to utilize the walnut in this area would necessitate negotiation with these landowners.

Volume estimates of walnut are difficult to determine because these trees grow intermittently in mixed hardwood stands. Mr. Tom Loring, forest products specialist for Region 3 estimated that between 0.5 MM and 1.0 MM board feet of walnut lumber could be produced annually from New Mexico and Arizona combined. However, exact volume figures and locations are not known at this time.

Species Description

The location and frequency of walnut trees appears to be directly related to creeks or irrigation ditches. They are considered riparian vegetation and grow within 500 feet of a stream or irrigation ditch.

Tree form and characteristics were examined. Trees along the Rio Bonito appeared to be naturally established. However, no pruning has been done to improve form.

A visual inspection of trees 16 inches dbh (diameter breast height) and over revealed the main trunk forking between 10 feet and 16 feet from the ground. Many of the forks were large and could possibly be utilized.

Natural regeneration was evident in the areas of the mature trees. Root suckers were present along with prolific sprouting from stumps.

Rot appeared externally in the form of conks at the base of trees and found in depressions where limbs were formerly broken off. Rot was found to be present in 33 percent (4/12) of the sample trees (Figures 6 and 7). Numerous pin knots were also noted for this species.

Table 6 contains data collected concerning the diameters and volumes of wood obtained from the harvested trees.

Table 6

Arizona Walnut Trees Harvested from Lincoln, New Mexico

Tree Number	dbh (inches)	Cubic Foot Volume
1	14.2	17.84
2	16.9	25.66
3	20.7	29.24
4	15.3	23.35
5	12.7	8.56
6	12.3	11.72
7	16.8	22.42
8	18.2	19.64
9	16.2	20.73
10	14.3	12.17
11	18.7	21.56
12	17.5	19.74
	$\bar{x}$ = 16.15 inches	233.66 Total Volume (cubic feet)

Tree volumes were calculated by Smalian's formula. The average diameter of the trees was 16.15 inches and the total volume harvested and processed was 233.66 cubic feet.

Initial moisture content of heartwood varied from 79 percent to 91 percent with an average moisture content of 84 percent for eight samples.

Green sapwood moisture content values of eight samples ranged from 65 percent to 80 percent with an average moisture content of 72 percent. Moisture content determinations were made by using the ovendry method.

Specific gravity determinations were made based on the green volume, ovendry weight. The range for thirteen samples was 0.54 to 0.64 with an average specific gravity value of 0.59.

Lumber Recovery

The lumber recovery factor of 6.92 was calculated for lumber milled at Dee's sawmill. The total volume of the logs was 159 cubic feet with a lumber yield of 1100 board feet. A lumber recovery factor of 4.24 was computed for the logs manufactured at the NAU bolter mill in Flagstaff. Total volume input was 75 cubic feet and the lumber yield output was 318 board feet. The major reason for the lower recovery rate at NAU was that only the small logs were processed there that averaged 7 inches in diameter.

Combined, the total volume of 234 cubic feet harvested from the twelve sample trees yielded 1,418 board feet of lumber. The overall lumber recovery factor was then calculated as 6.06.

Table 7 summarized kiln schedules employed, initial moisture contents, and total drying times for walnut lumber.

Table 7

Drying Data for 4/4 and 8/4 Walnut

Kiln Schedule	Charge No.	Date Started	Moisture Content Range %	Initial Moisture Content % Av. (6 Samples)	Conditioning Time (Hours)	Total Drying and Conditioning Time (Days
T6-D4	1	6/03/78	53-95	72	20	18
T6-D4	2	6/21/78	54-80	60	21	18
T7-D4	3	7/11/78	48-91	62	19	14
T8-D5	4	7/26/78	72-95	80	20	16
T6-D4	5	8/14/78	52-73	63	20	18
T6-D4	6	9/02/78	51-79	63	20	20
T6-D4	7	9/24/78	62-86	71	20	20
T6-D4	8	10/17/78	54-69	58	20	18
T3-D3	9*	11/18/78	55-80	67	48	62
T6-D4	10	2/18/79	13-28	22	20	13
T6-D4	11	3/02/79	14-23	19	20	14
T3-D3	12*	3/16/79	10-15	13	48	10
T3-D3	13*	4/02/79	11-17	15	20	10
T6-D4	14	4/12/79	10-18	14	20	10
T6-D4	15	4/23/79	11-15	13	20	11
T6-D4	16	5/02/79	8-12	11	20	9
T6-D4	17	5/11/79	11-27	18	20	8

* Denotes 8/4 lumber dried; no asterisk denotes charges of 4/4 lumber dried

For the 8/4 lumber with an average moisture content of 50 percent, drying time of the charge to a moisture content of 7 percent took 62 days, including a 48 hour conditioning period. Schedules used for both sizes of lumber were the mildest ones recommended.

Charges 1 through 9 were all run with green walnut. Charges 10 through 17 were run for lumber that had been stacked, air-dried, stickered, and placed indoors.

All lumber had a silicone end-coating placed on each end prior to drying (Figure 3).

One bunk was air-dried from August 18, 1978 to October 30, 1978. The moisture content of the four 4/4 sample boards dropped from an average initial moisture content of 54 percent to an average moisture content of 12.58 percent. The single 8/4 sample board moisture content dropped from a moisture content of 84 percent to 42 percent during the same time period. Visual examination showed no degrade with this method.

Ambient conditions in the bunk of lumber under the polyethylene sheet inside the laboratory maintained an approximate temperature of 74 degrees Fahrenheit and a relative humidity of 40 percent. Under those conditions, drying continued from August 15, 1978 until January 28, 1979. The three 4/4 green samples had an initial average moisture content of 78 percent and dried to an average moisture content of 10 percent. The 8/4 sample had an initial moisture content of 60 percent and was dried to a moisture content of 11 percent during the approximate 5 month period. Defects associated with drying were minimal.

Three different drying schedules were used for the 4/4 lumber and one schedule was used for the 8/4 lumber. Table 8 describes the results obtained for all charges with regard to the various grades obtained.

For the total lumber yield, 518.58 board feet or 37 percent was found to be No.1C or better grades, based on the National Hardwood Lumber Association's (NHLA) Grading Rules for black walnut. No.2C was the NHLA grade that had the greatest single amount, 41 percent (580.21 board feet). NHLA grade No.3C and B.G. (below grade) categories had a total of 319.80 board feet or 23 percent of the total.

It should be noted that possibly a greater proportion of lumber might have met higher grades if the experimental dry kiln had not been limited the lumber to a maximum length of 7 feet.

Table 8

Grade Recovery from Kiln Dried Arizona Walnut

Kiln Charge	F & S	S	No.1C	No.2C	No.3C	BG	Board Footage
1			17.24	32.01	28.00	7.84	85.09
2			23.67	22.82	20.34	17.21	84.04
3			18.24	29.37	33.98	20.54	102.13
4			11.67	56.13	45.13	6.67	119.60
5			45.33	25.52	6.71		77.56
6			13.89	56.97	14.86		85.72
7			15.42	59.63	11.41		86.46
8		4.5	12.25	60.43	1.0	4.66	82.84
9*			20.17	69.14	44.58	7.16	141.05
10			3.12	29.80	30.28	10.07	73.27
11			26.92	31.64	5.32	1.54	65.42
12*	22.46	54.73	31.18	18.22			126.59
13*	7.08	7.16	44.66	23.19			82.09
14		27.79	16.26	26.19			70.24
15	4.70	17.06	21.09	9.45	2.50		54.80
16			32.66	12.63			45.29
17			19.33	17.07			36.40
	34.24	111.24	373.10	580.21	244.11	75.69	1418.59
Proportion of total:	3%	8%	26%	41%	17%	5%	100%

* Denotes 8/4 lumber; no asterisk denotes 4/4 lumber

Lumber was dried from the green condition to 7 percent moisture content in the kiln for charges 1 through 9. Charges 10 through 17 were air-dried and then placed in the kiln for final drying and stress relief treatment. Figures 10 and 11 illustrate walnut boards after drying and conditioning. Table 9 shows a comparison of lumber grades by total kiln drying as compared with partial air-drying, and then kiln drying.

Table 9

Lumber Grades Charges 1-9 (kiln dried), and Charges 10-17 (air and kiln dried)

	F & S	S	No. 1C	No. 2C	No. 3C	B.G.	Board Feet
Charges 1-9		4.50	177.88	412.02	206.01	14.08	864.49
Charges 10-17	32.24	106.74	195.22	168.18	38.10	11.68	554.10
						Total	1418.59

In charges 1-9, only 1 percent of the total lumber for those charges kiln-dried was found in No. 1C grades and better, whereas for charges 10-17, 61 percent of the lumber that had been previously air-dried outside or under a polyethylene wrap and then kiln dried was found in the No. 1C and better grades.

These grade differences were readily apparent especially with charge number 4, the most severe schedule for the 4/4 stock, and to a lesser degree with charge number 3, the intermediate schedule. No attempt was made to grade the lumber prior to drying.

In visual assessment of lumber degrade, the most prevalent problem appeared to be collapse and/or shake, especially throughout the central

region around the pith of the log (Figures 8 and 9). This problem was evident in approximately 50 percent of the total volume and 70 percent of the lumber which was kiln dried from the green condition. To a minimal degree, splinter pull and insect damage were observed (Figures 4 and 5) in the lumber.

Products manufactured from the walnut from the four firms included the following: end tables, bar stools, dinette table, plant stand, picture frames, turned chair, sculpture base, and plaques. Some of these products are found in Figures 12 through 21.

Table 10

Rating of Arizona Walnut in Comparison with other Hardwoods Four Firms have Used

Characteristics	Above Average	Average	Below Average	Poor
Sanding	2	2		
Machinability	2	2		
Natural defects			2	2
Seasoning defects			3	1
Gluing		4		
Finishing	1	3		
Hardworking		4		
Checking		4		
Other: Specify				

Woodworking characteristics for this species were classified as either average or above-average. The natural defect and seasoning defect categories were problem areas and rated below-average or poor. Little can be done with respect to natural defects but as far as seasoning defects are concerned, proper drying could possibly increase the quality of the wood.

In response to the question, "If this wood were made available to you at a reasonable cost, what would be your response to obtaining more of it?" the wood manufacturers checked the following answers:

XX a. Greatly impressed, request more.

X b. Moderately impressed, request more.

*X c. Not impressed.

* Note following comments from this firm in text

Three of the four firms marked the response indicating they were impressed with the wood and would request additional supplies. In these three instances, the wood manufactures are small, owner-craftsmen businesses, that basically do custom woodworking orders. Their wood supply is purchased mostly through wholesale lumber yards and the grades of lumber they used mostly depended on the nature of the product and the customer's wants. The fourth wood manufacturer that marked the "not impressed" response employs several craftsmen and is currently using F&S grade black walnut for his operations. The owner and shop foreman indicated that they could switch part of their walnut requirements to the lower grades available if the price were in the $400-$500 Mbf range. The current price this firm pays is $2,400-$2,600 Mbf for F&S black walnut.

SUMMARY

As a result of this study it was evident that there is a substantial volume of Arizona walnut in the riverbed areas near Capitan, Lincoln, and Hondo, New Mexico. Several trees are overmature and are being destroyed by fungal activity.

Landowners in that area are willing to sell their walnut trees. The stumpage price will need to be negotiated with one of the three major landowners in that area.

Tree diameters vary, but a 16-20" diameter tree dbh was most frequently found in that area.

The most successful method of drying the walnut was found to be air drying followed by kiln drying and subsequent stress removal.

If the lumber is totally kiln dried, the mildest dry kiln schedule for black walnut is recommended. The minimum time for drying green 4/4 stock was 20 days, and for 8/4 stock 64 days.

Air-drying of lumber outside took approximately 2.5 months when dried from a green condition to 12 percent moisture content. If lumber is to be resawn, however, stresses must be relieved as casehardening resulted in each sample from the air-dried bunk. An alternative to outside air-drying is placing the lumber inside enclosed by polyethylene film. Even though the time period for drying was longer than the air-dry method, this method can be done very inexpensively.

Wood manufacturers viewed the wood with cautious enthusiasum. The wood was used for very unique small furniture projects or handcrafted items.

A major item of interest expressed by manufacturers was the price of stumpage, location of the supply, and how it could be dried.

CONCLUSIONS

From this study the following conclusions could be drawn:

1. At present, Juglans major, Arizona walnut is not being utilized to its fullest potential.

2. Private landowners who have walnut on their property in Lincoln, New Mexico area expressed a willingness to negotiate a price for their stumpage.

3. Air-drying the lumber with final kiln drying and conditioning seemed to be the best method of drying the walnut.

4. The walnut seems to be well-suited for making small furniture and handcrafted items.

5. Wood manufacturers expressed varying degrees of interest and were very inquisitive about availability and costs.

6. Successful utilization of this species will probably require an intermediary (person(s)/firm(s)) that would need to accomplish the following: consummate stumpage purchase, harvest and transport the trees to a milling site, dry the lumber, and sell it in the marketplace.

REFERENCES

National Hardwood Lumber Association. 1978. Rules for the Measurement and Inspection of Hardwood and Cypress Lumber. National Hardwood Lumber Association. Chicago, IL.

Rasmussen, Edmund. 1961. Dry Kiln Operator's Handbook. Agriculture Handbook No. 188. U.S.D.A. Forest Products Laboratory, Forest Service, Madison, WI.

Appendix A: Photographs

Figure 1

Cross Section of Juglans major, Arizona walnut

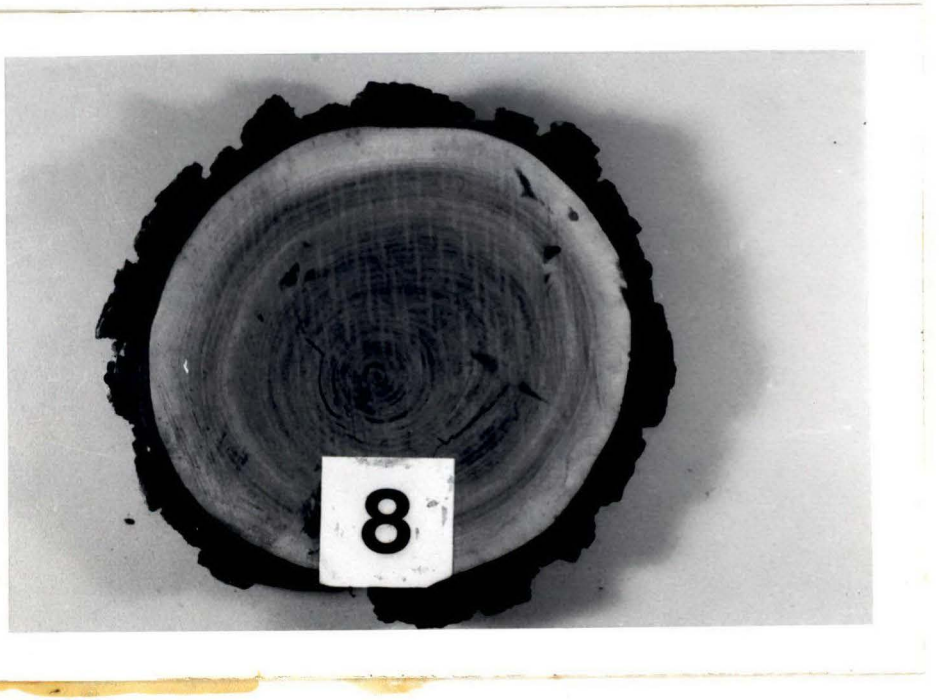

Figure 2

Juglans Major

Walnut Fruits

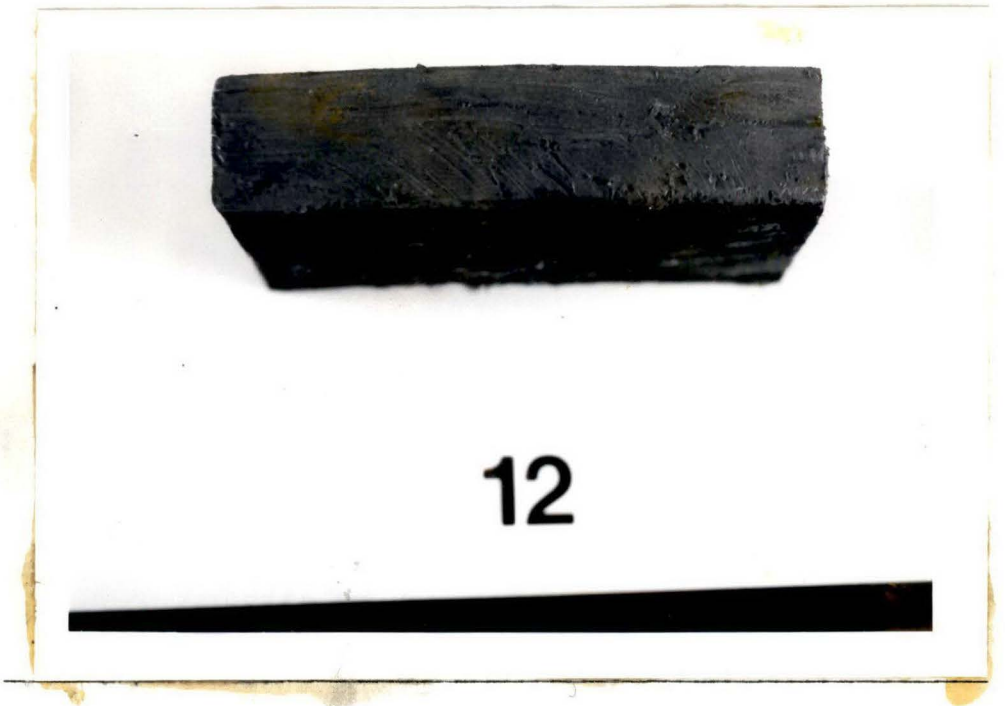

Figure 3

Silicone Treatment of Walnut Ends

Figure 4

Splinter Pull

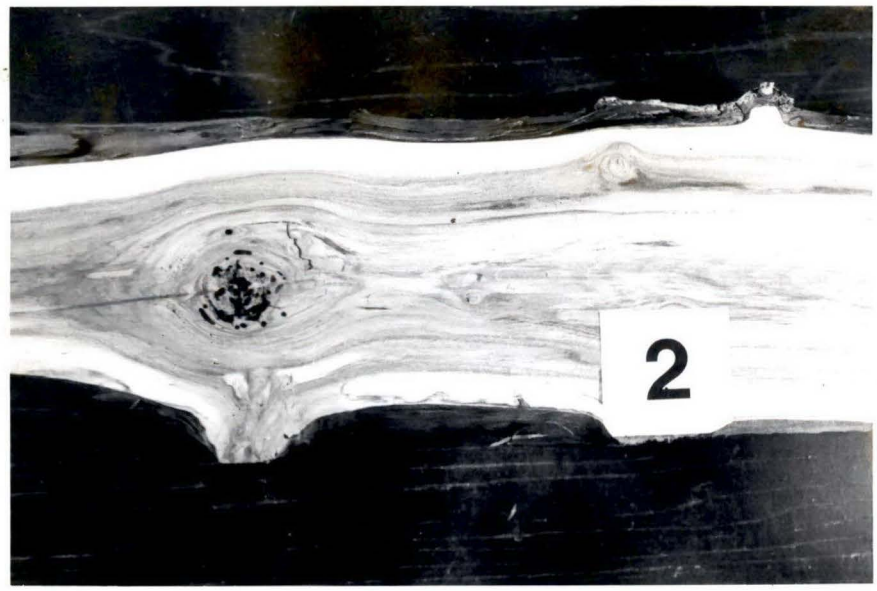

Figure 5

Insect Damage in Knot

Figure 6

Heartrot

Figure 7

Heartrot

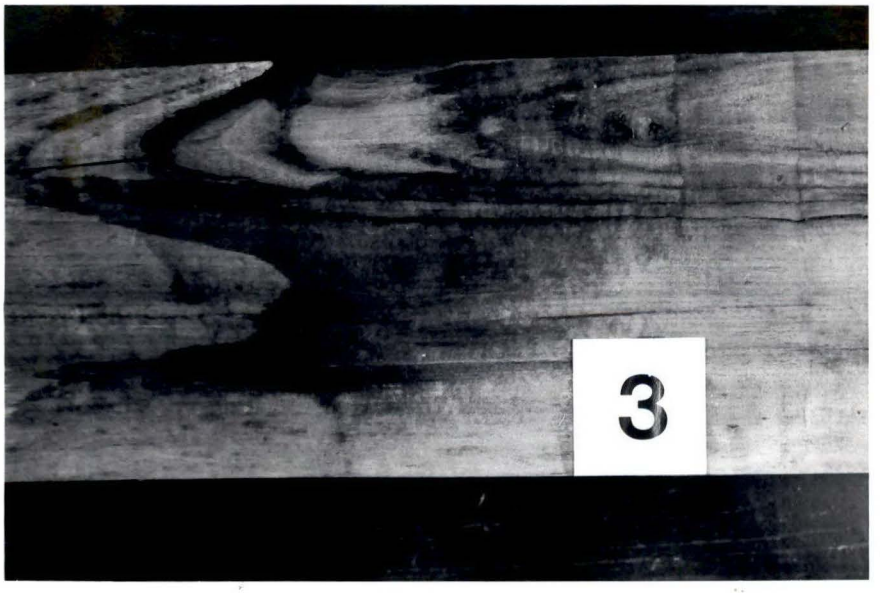

Figure 8

Shake

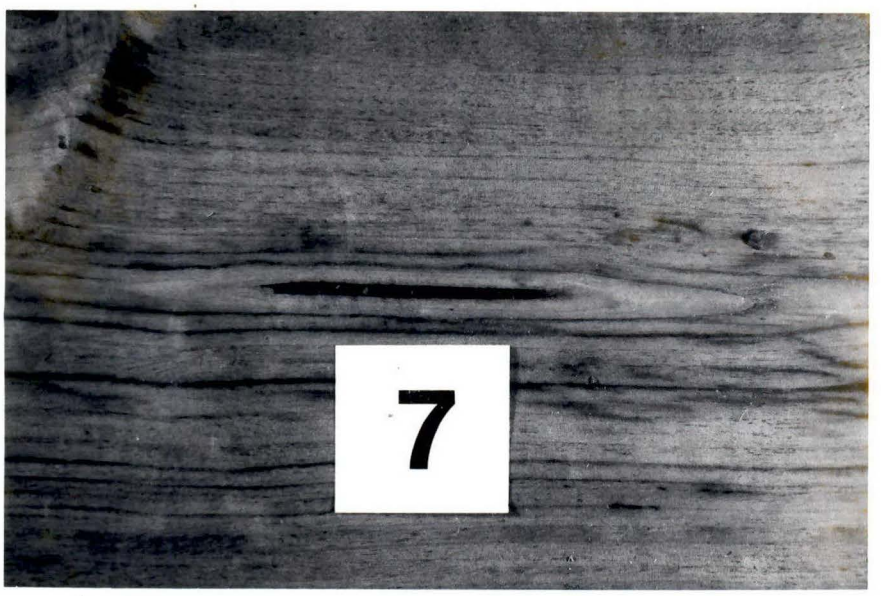

Figure 9

Collapse and Shake

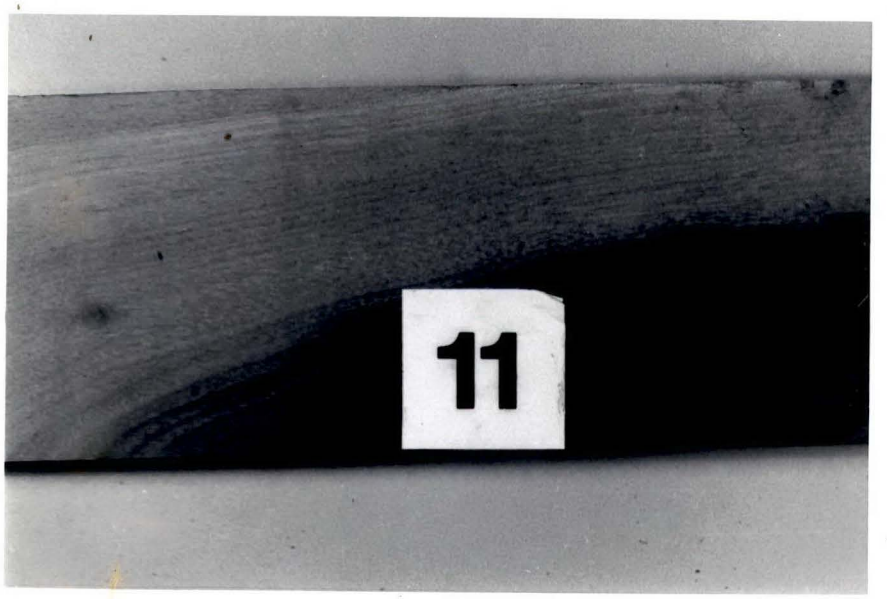

Figure 10

Sapwood and Heartwood after Conditioning

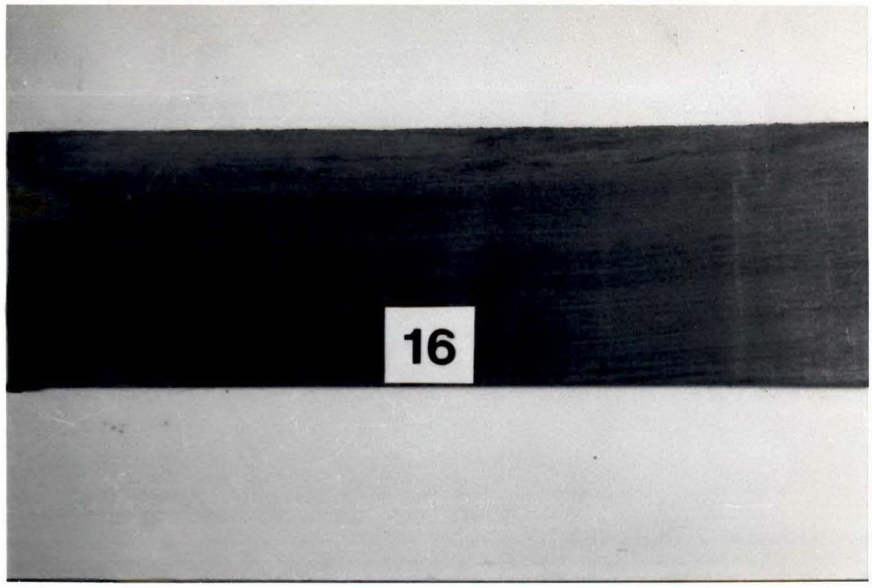

Figure 11

Heartwood Board

Figure 12

Glass Coffee Table

Figure 13

Walnut Coffee Table

Figure 14

Walnut End Table

Figure 15

Walnut Base

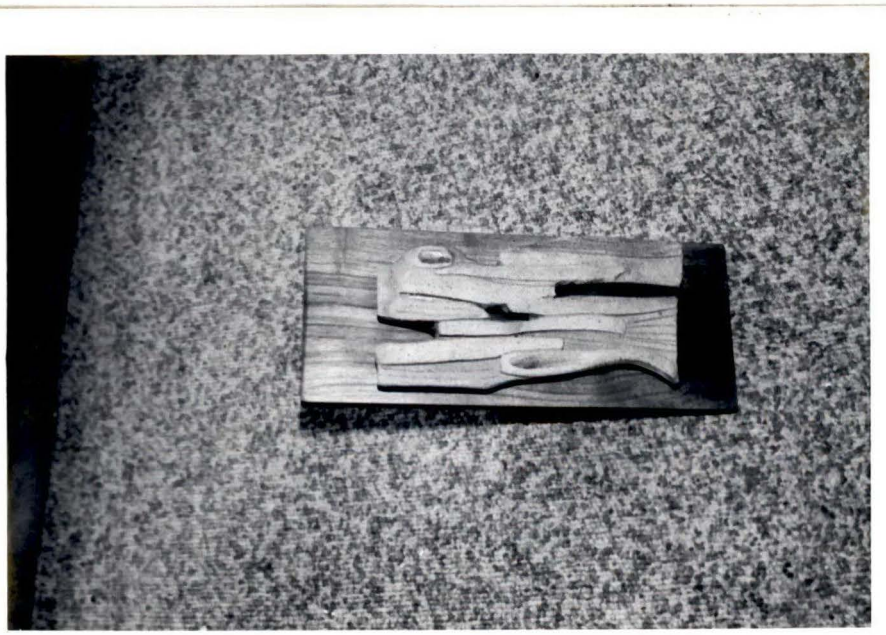

Figure 16

Walnut Modern Art Plaque

Figure 17

French-Canadian Style Chair with Woven Rush Seat

Figure 18

French-Canadian Style Chairs with Woven Rush Seat